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What is the best treatment for adult distal 1/3 humerus fractures?

Best treatment for humerus fractures

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Abstract
Aim: Adult humeral fractures that do not extend to the elbow joint can be seen in low-energy trauma in the elderly and high-energy trauma in the young. Fractures of the distal 1/3 of the humerus are treated with surgical and non-surgical methods. Our study aimed to evaluate the functional and radiological results of the distal 1/3 humerus fractures, which do not involve the joint, by comparing the conservative and surgical treatments and the surgical techniques used.
Material and Methods: Thirty-five patients with adult distal 1/3 humeral fractures that did not extend to the joint between January 2010 and October 2014 were included in the study. The cases were evaluated retrospectively.
Results: Nine of the cases were female and 26 were male. The mean age of the patients was 33,6. The articular range of motion (ROM) of cases was measured at an average of 118,8˚, and extension loss was measured at an average of 7,14˚. The average Mayo score of cases was measured at 87. Mono plaque osteosynthesis was applied to 20 of all cases (Group I), double plate osteosynthesis was applied to 11 (Group II), and conservative treatment was applied to 4 (Group III). A statistically significant difference between Group I and Group II was not been determined regarding union time, complication, Mayo Score, Cassebaum's rating, ROM, and extension loss. According to surgical approaches applied to patients (lateral-posterior), while no statistical difference was determined regarding complications, union time, and ROM, a significant difference was determined regarding Mayo Score and extension loss. According to different determination methods, a statistical difference was not been determined regarding complications, ROM, extension loss, Mayo Score and union time.
Discussion: We recommend surgery with a lateral approach to preserve the extensor mechanism in fractures of the distal 1/3 of the humerus.

Keywords
Humerus Distal Fractures, Surgical Treatment, Conservative Treatment, Mayo Score

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Introduction

The elbow joint is a structure that has an important role in the fulfillment of daily life activities. The elbow joint plays a role in the wrist and hand functions through the radius and ulna. If fractures of the radius, ulna and distal humerus are not treated appropriately, serious loss of function is observed in the upper extremity [1].

Today, methods used in the treatment of humeral diaphyseal and distal region fractures can be grouped into two main groups as conservative and surgical. In addition to the fracture location and type, its anatomical proximity to neurovascular structures forced the surgeon to consider different treatment plans for each fracture [2]. Due to its tight neighborhood, radial nerve and vessel injury pose a potential risk. Immobilization of the joint for a long time can lead to limitation of movement and union disorders in the shoulder and elbow [3]. When the advantages and disadvantages of both surgical and conservative treatment methods are evaluated, one of the most discussed bone fractures about the treatment method to be applied is humeral fractures. There is still no consensus between conservative treatment and surgical treatment in distal humeral fractures that do not involve the joint, and there is no consensus in terms of fixation with a single plate or double plate even in surgical treatment.

In this study, we aimed to evaluate the functional and radiological results of conservative treatment and surgical treatments (Single Plate? / Double Plate?) preferred in the treatment of distal 1/3 humeral fractures that do not involve the joint.

Material and Methods

Ethical Statement

The study received ethical approval from Firat University Clinical Research Ethics Committee (Approval No: 29798557/903.99. Date: 2015-02-09). This study was carried out in accordance with the Declaration of Helsinki.

Study Design

Patients with a follow-up period of at least 24 months, treated for adult distal 1/3 humeral fractures, according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification types 12-A/B/C and 13-A, not extending to the elbow joint, between January 2010 and October 2014, in a single center were included in the study.

In our retrospective study, patients who were treated by another clinic and then underwent revision surgery by our clinic, patients who were treated by our clinic but were not followed up, patients with missing and/or suspicious information in the hospital information management system or patient files, and pediatric patients were excluded from the study. Considering the inclusion and exclusion criteria, 35 patients out of 41 were included in the study.

By examining patient files retrospectively, age, gender, type and date of trauma, type of fracture according to the AO classification, additional pathologies, if any, type according to Gustillo-Anderson fracture classification, the time elapsed before surgery, surgical approach and technique used, duration of follow-up, the month of fracture union, complications, and the difference in the carrying angle between the elbows of the cases were evaluated. Anteroposterior and lateral radiographs and radiological evaluations, goniometric elbow joint range of motion (ROM) and extension loss were measured in the last outpatient clinic controls of the cases. The Mayo Elbow Performance Score and Cassebaum rating system were used to evaluate the functional outcomes of the cases.

Statistical analysis

Statistical Package for Social Sciences (SPSS) for Windows 16.0 program was used for statistical analysis. Chi-Square, Student-t, Annova and Correlation tests were used for statistical analysis. The results were evaluated at 95% confidence interval and the significance level of $p<0.05$.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Group I consisted of 20 patients (57%) with single plate osteosynthesis, 11 (31.4%) patients with double plate osteosynthesis, and Group III with 4 patients (11.6%) treated with conservative treatment.

Among patients of Group I, 12 (60%) were male and 8 (40%) were female. There were fractures in the right humerus in 10 cases and in the left humerus in 10 cases. The mean age was 36.15 (±16.5). Seven (35%) of the cases were open fractures and 13 (65%) were closed fractures. Of the open fractures, 3 were Type 1, 1 was Type 2, and 3 were Type 3. According to the AO/ASIF classification, 6 (30%) of the cases in Group I were 12-A1.3, 3 (15%) 12-A3.3, 2 (10%) 12 B1.3, 4 (20%)) 12-B2.3, 1 (5%) 12-B3.3, 2 (10%) 13-A2.1, 2 (10%) 13-A3.3 type fractures. The mean follow-up period was 43.9 (±17.4) months.

Among cases in Group II, 10 (90.9%) were male and 1 (9.1%) was female. Six of them had right humerus fractures and 5 of them had left humerus fractures. The mean age was 33.6 (±14.8) years. 1 (9.1%) of the cases were open fractures and 10 (90.9%) were closed fractures. The open fracture was Type 2. According to the AO/ASIF classification, 4 (36%) of the cases in Group II were 12-A1.3, 3 (27%) 12-B1.3, 1 (9%) 12-C1.1, 1 (9%) 12-C3.2, 1 (9%) 13-A2.3, 1 (9%) 13-A3.2 type fracture. The mean follow-up period was 36.36 (±14.53) months.

The cases were compared according to the applied surgical technique. Group I consisted of 20 (65%) patients with a single plate and Group II of 11 patients (35%) with a double plate. The groups were statistically similar in terms of gender, age, side, fracture type according to Gustilo-Andersona classification, fracture type according to AO classification, duration of follow-up, trauma mechanism and time to surgery. Although the follow-up period of Group I was longer, it was not statistically significant. Group I and Group II were statistically different in terms of the surgical opening method ($p<0.05$). While more lateral incisions were made in the single-plated group, it was seen that both lateral and posterior incisions were used in the double plated group. The mean operation time of the cases in Group I was 97 minutes, while the mean operation time of the cases in Group II was 153.6 minutes. It was observed that 6 (30%) of the cases in Group I received blood transfusion, while 2 (18%) of the cases in Group II received blood transfusion (Table 1).

All of the cases in Group III were male. The mean age was

Table 1. Comparison Table of Patients.

		SURGERY							CONSERVATIVE TREATMENT (n=4) (%11,6)		Total (n=35)		CONSERVATIVE Versus SURGICAL TREATMENT
		One plate (n=20) (%57)		Double plate (n=11) (%31,4)		Total (n=31) (%88,4)		Comparison of surgical fixation methods					
		N	%	N	%	N	%		N	%	N	%	
Gender	Male	12	60%	10	90,90%	22	71%	p: 0,07	4	100%	26	74,30%	p: 0,28
	Female	8	40%	1	9,10%	9	29%				9	25,70%	
	Left	10	50%	5	45,50%	15	48,40%		1	25%	16	45,70%	
The average age		36,15 (SD:16,5)		33,60 (SD:14,8)		35,25 (SD:1,57)(18-72)		p: 0,67	20,75 (SD:2,21)		33,6 (SD:15,5) (18-72)		p: 0,79
AO classification	12-A	9	45%	4	36,40%	13	41,90%	p: 0,27	2	50%	13	37,10%	p: 0,034
	12-B	7	35%	3	27,30%	10	32,30%				12	34,30%	
	12-C			2	18,20%	2	6,50%		2	50%	4	11,40%	
	13-A	4	20%	2	18,20%	6	3,20%				6	17,10%	
Gustilo Aderson classification	Closed Fracture	13	65%	10	90,90%	23	74,20%	p: 0,10	4	100%	27	77,10%	p: 0,72
	Type 1	3	15%			3	9,70%				3	8,60%	
	Type 2	1	5%	1	9,10%	2	6,50%				2	5,70%	
	Type 3	3	15%			3	9,70%				3	8,60%	
Surgery approach	Lateral	18	90%	5	45,50%	23	74,20%	p: 0,02					
	Posterior	2	10%	5	45,50%	7	22,60%						
	Medial-Lateral			1	9,10%	1	3,20%						
Mayo Score Average		86,5 (SD:12,3)		84,54 (SD:10,3)		85,80 (SD:11,55) (65-100)		p: 0,66	96,25 (SD:7,5)		87 (SD:11,58) (65-100)		p: 0,045

Table 2. Relationship between Time of Operation and MAYO Score, Joint Range of Motion, and Loss of Extension.

	Time of Operation	Number of patients	Mean	Standard Deviation	Lowest	Highest	p
Mayo elbow scoring points	In the first 24 hours	8	76,875	8,83883	65	85	0,008
	1-3. Day	7	89,2857	7,31925	85	100	
	3-7. Day	9	93,8889	9,61047	75	100	
	7-14. Day	6	80	12,64911	65	100	
	After the 14th day	1	95		95	95	
	Total	31	85,8065	11,55399	65	100	
Range of motion	In the first 24 hours	8	118,75°	13,82286°	100°	140°	0,409
	1-3. Day	7	120,71°	9,32227°	110°	130°	
	3-7. Day	9	120°	17,13914°	90°	140°	
	7-14. Day	6	106,67°	15,05545°	90°	120°	
	After the 14th day	1	120°		120°	120°	
	Total	31	117,26°	14,36655°	90°	140°	
Loss of extension	In the first 24 hours	8	6,25°	6,4087°	0	20°	0,249
	1-3. Day	7	3,5714°	4,75595°	0	10°	
	3-7. Day	9	8,8889°	11,39566°	0	30°	
	7-14. Day	6	13,3333°	8,16497°	0	20°	
	After the 14th day	1	0		0	0	
	Total	31	7,5806°	8,55092°	0	30°	

Table 3. Comparison of the surgical approach Methods of the Cases.

	Approach	Number of patients	Mean value	Standard Deviation	p
Mayo Elbow Performance Score	Lateral	23	86,875	12,40726	0,039
	Posterior	7	82,1429	7,55929	
Range of Motion	Lateral	23	119,38	14,69343	0,131
	Posterior	7	110	11,18034	
Extension Loss	Lateral	23	6,0417	8,46722	0,048
	Posterior	7	12,8571	6,98638	
Union Time (Month)	Lateral	23	4,9792	3,53086	0,736
	Posterior	7	4,5	2,06155	
	Posterior	7	0,5714	0,7868	

20.75 (±2.21). Three of the fractures were right and one was left. All of them were closed fractures. According to the AO/ASIF classification, 1 (25%) case in Group III had 12-B1.3 type fracture, 1 (25%) had 12-B2.3, 1 (25%) had 12-C1.1, 1 (25%) had 12-C2.1 type fracture. The mean follow-up period was 36 (±6.97) months.

When the cases that underwent surgery (Group I-Group II) and the cases that were treated conservatively were compared, there was no significant difference in terms of gender (p:0.28), side (p:0.37), mean age (p:0.79), fracture type according to Gustilo- Anderson classification (p:0.72) and follow-up time (p:0, 54). However, a statistically significant difference was found in terms of fracture type (p:0.034) according to the AO classification.

When the cases that underwent surgery (Group I-Group II) and the cases that were treated conservatively were compared, no significant difference was detected in the type of trauma (p:0.14), mean follow-up time (p:0.54), mean time to union (p:0.55), complication (p:0.63), mean ROM (p:0.46), loss of extension (p:0.39), Mayo Score evaluation (p:0.23), Cassebaum rating (p:0.14), and time to union of fractures according to Gustilo-Anderson fracture typing (p:0.21). In addition, a significant difference was found in terms of the mean mayo score (p:0.045) (Table 1).

According to the duration of surgery of the cases, there was no statistically significant difference in terms of ROM (p:0.409) and loss of extension (p:0.249). However, a statistically significant difference was found in terms of Mayo Elbow Scoring (p:0.008) (Table 2). A statistically significant relationship was found between the two groups according to surgical approaches (p:0,02) (Table 2).

According to the applied surgical approaches (lateral-posterior), no statistically significant difference was found in terms of complications (p:0.968), union time (0.736), ROM (p:0.131). However, a significant difference was found in Mayo Score (p:0.039) and loss of extension (p:0.048) (Table 3).

While there was a statistically significant relationship between implant failure and Y-Plate between the groups (p:0.048), there was no relationship between plating and implant failure in general (p:0.456). No significant correlation was observed between the plating technique and complication (p:0.279). When we examined it according to the Mayo Elbow Performance Scoring, no significant correlation was observed between plating technique and complication (p:0.678).

Discussion

The elbow joint is a structure that has an important role in the fulfillment of daily life activities. If fractures involving the elbow joint are not treated appropriately, serious loss of function is observed in the upper extremity [1].

Humerus fractures show a bimodal distribution considering age and gender. According to the energy level, injuries can be divided into two groups as high-energy traumas and low-energy traumas. Especially in the young population, open fractures and other system injuries are more likely to occur because they occur as a result of high-energy traumas [4, 5]. In our study, in accordance with the literature, we mostly see it after high-energy traumas in young patients, and mostly after low-energy traumas such as simple falls in elderly patients.

Treatment recommendations for 1/3 distal diaphysis and distal end extra-articular fractures of the humerus are largely based on studies evaluating non-surgical treatments such as functional braces [6,7], and some surgeons advocate surgical treatment for these fractures. Advocates of conservative treatment state that surgery is unnecessary for these patients because of the risks of complications such as infection and neurovascular injury [7-12].

According to O'Driscoll [13], the ideal approach should provide sufficient view, it can be extended when necessary, it should be in the form of a soft tissue dissection without osteotomy, dissection should be in the plane of the nerves and should not cross the nerves, all alternative surgical procedures can be applied with the same opening, allowing early rehabilitation, and possible revisions should be made with the same incision.

In our study, the lateral incision was preferred more frequently. Compared with patients who had posterior and double incisions, it was observed that the Mayo score was better and the loss of extension was less in patients with lateral incisions. We believe that the single incision causes less loss of extension, faster rehabilitation of the patients and better elbow functions (Mayo Score) by causing less damage to the extensor mechanism, especially when compared to the double incision.

Although there is ample evidence that bicolumnar support is advantageous for intra-articular fractures, uncertainty remains as to whether double-plating is necessary for extra-articular supracondylar humeral fractures [14].

The disadvantages of using double plate fixation with a posterior exposure are the wide surgical exposure required to the posterior and medial aspects of the elbow. Ulnar nerve injury, postoperative wound problems, and elbow stiffness are frequently reported complications associated with double plate fixation [15, 16, 7]. It is mentioned in the literature that a single plate was used as a reduction tool before [17]. The lateral plate is not only a means of reduction, but also functions as a structural support. One of the methods used to reduce the surgical risk is the application of a single plate with only lateral exposure. Some authors [7, 18] recommend fixation with a single posterolateral plate to avoid excessive stripping of large soft tissue and reduce surgical time. Some studies [18, 19] showed that a single plate is sufficient for the fixation of extra-articular humeral distal fractures. Yet another study [14] found that posterolateral locking single-plate and orthogonal anatomical double-plate were biomechanically equivalent in distal humerus extraarticular supracondylar fractures.

In our study, no statistically significant difference was found between the two groups in terms of complication, union time and functional outcome in single plate or double plate fixation method. Since there is only one case in which the Y plate was made, it is not correct to comment on the Y plate in a statistical sense.

The normal range of motion of the elbowis 0°-150° flexion, 85° supination, 85° pronation [20]. The most commonly used range of motion in daily life is 30°-130° flexion, 50° supination, 50° pronation [20]. In our study, the mean range of motion was 118.8˚ and the mean extension loss was 7.14˚. We assessed that the mean range of motion of the joint supported the

recovery of elbow joint functions. While no significant difference was found between surgical techniques (Group I and Group II) in terms of ROM, when the patients who underwent surgery (Group I-Group II) were compared with the patients who were treated conservatively, the range of motion of the patients who were treated conservatively was significantly better.

In our study, we encountered 16% of complications. Of these, 13% were delayed union and 3% were nonunion. Our patients with non-union problem were re-operated, the implant used for fixation was changed (we revised the single plate with a double plate), and union was achieved by resuscitating the fracture line.

Ulnar neuropathy may occur during initial injury or iatrogenically during surgical fixation. While ulnar nerve lesion due to humeral distal end fractures or treatment is observed between 3-8%, the incidence of ulnar neuropathy during surgical fixation has been reported to be 0-12% [21,22,12]. The anterior transfer of the ulnar nerve is controversial. The ulnar nerve was not transposed anteriorly in the patients included in our study. No iatrogenic nerve damage was observed in our patients.

There are some limitations of our study. The low number of patient groups and the presence of many variable factors prevented us from obtaining statistically significant results. Prospective, randomized, multicenter studies with large numbers of patients are needed.

Conclusion

In these fractures, which are seen after high-energy trauma in young patients and after low-energy trauma in elderly patients, post-traumatic neurovascular structures, especially ulnar nerve examination, should be careful. The Association for Osteosynthesis (AO) classification alone cannot help predict prognosis. The type of fracture (according to AO and Gustilo-Anderson), together with the treatment protocols applied to the patient, affects the patient's compliance in post-surgical rehabilitation. Early initiation of joint range of motion exercises is of great importance for the success of treatment methods. We recommend surgery with a lateral approach to preserve the extensor mechanism in fractures of the distal 1/3 of the humerus.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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